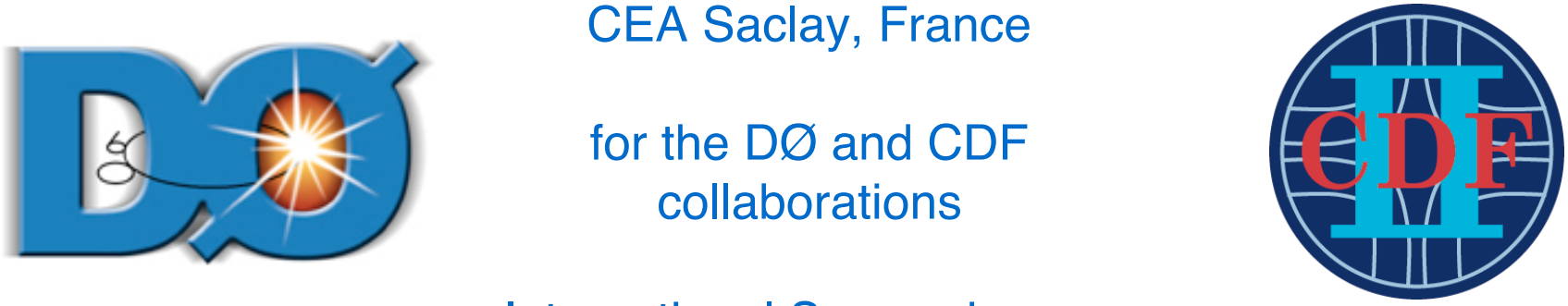
Recent QCD results from Tevatron

Pavel Demine
CEA Saclay, France

for the DØ and CDF collaborations



International Symposium on Multiparticle Dynamics

September 5 — 11, 2003

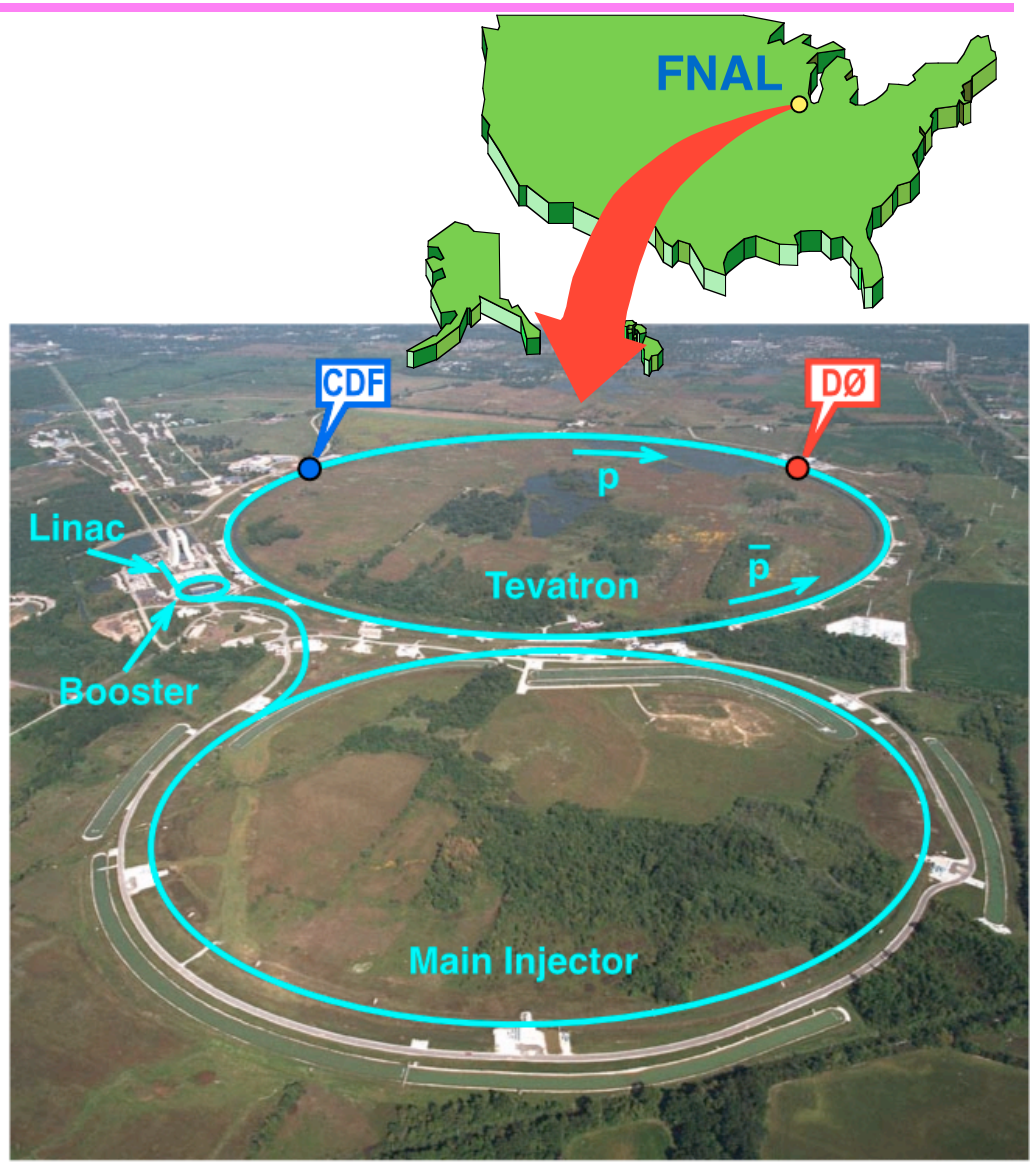
The Tevatron Run II

Tevatron upgrade (1996-2001):

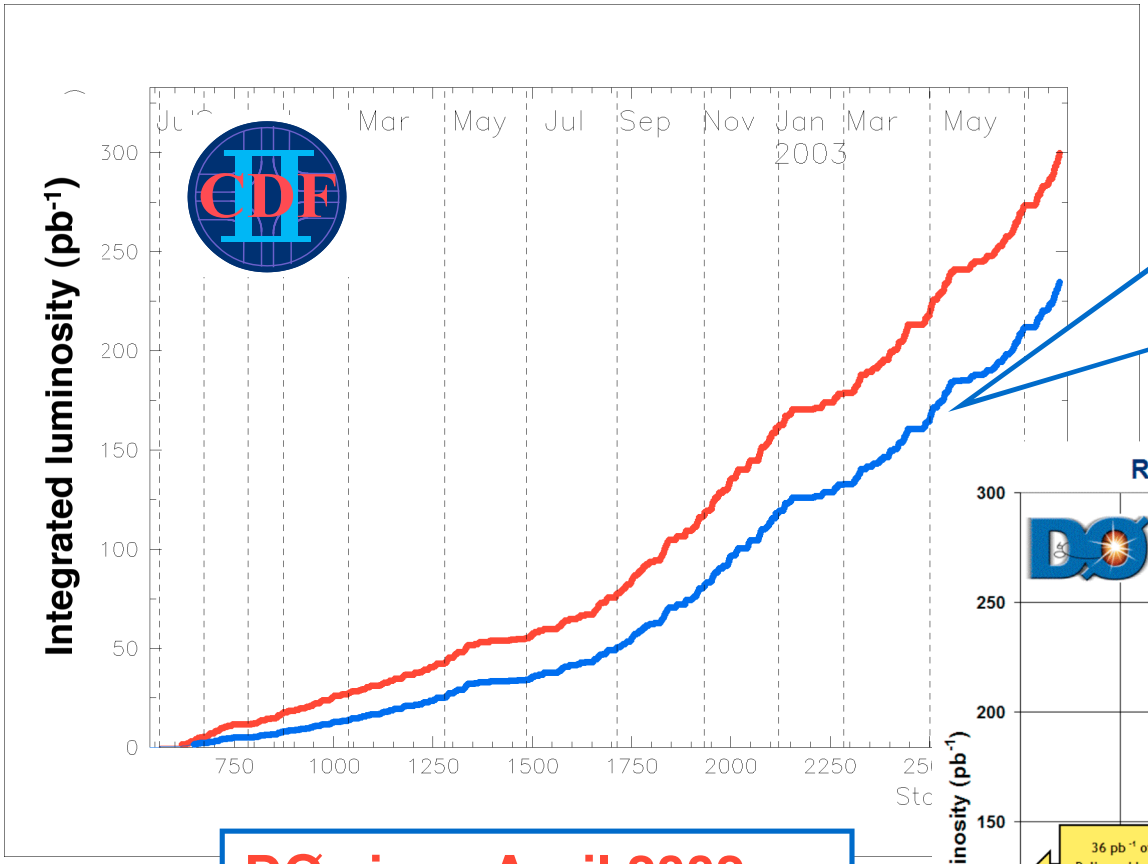
- **Energy upgrade:**
  - **1.8 → 1.96 TeV**
- **Increased N(bunches):**
  - **6 x 6 → 36 x 36**
- **Improved $\bar{p}$ production**
  - **Main injector, target**
- **Improved p production**
  - **Main injector**

Run II expectations:

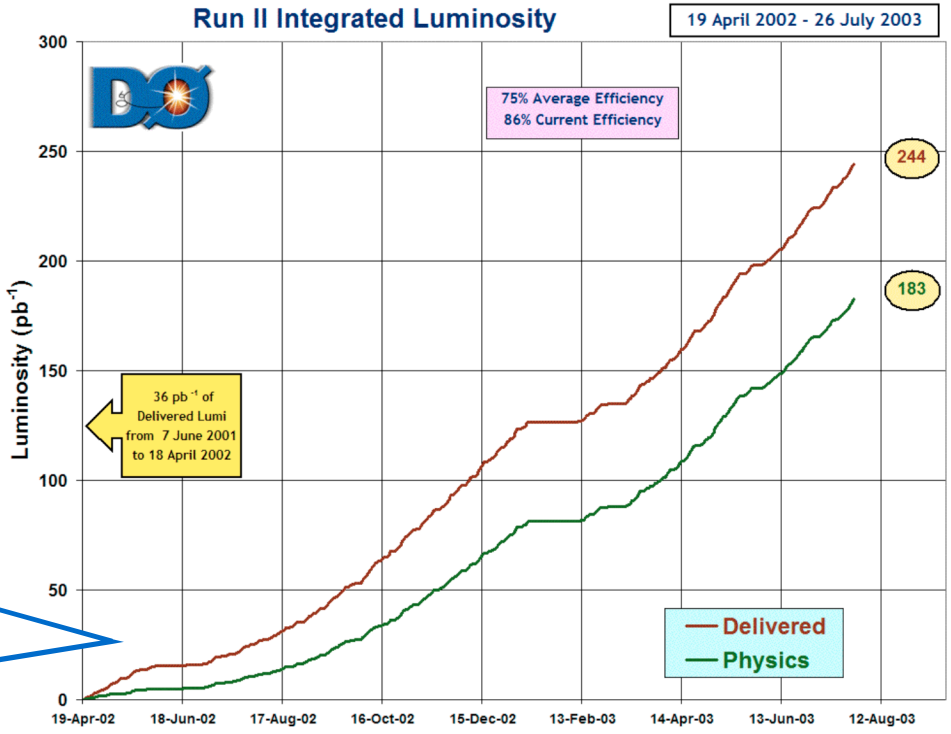
- **Started March 1st, 2001**
- **Expected luminosity**
- **→ > 200 pb^{-1} (delivered) Oct. 2003**
- **→ 2 fb^{-1} by 2005**
- **→ > 8 fb^{-1} by start of LHC**



CDF and DØ status: Run II > Run I



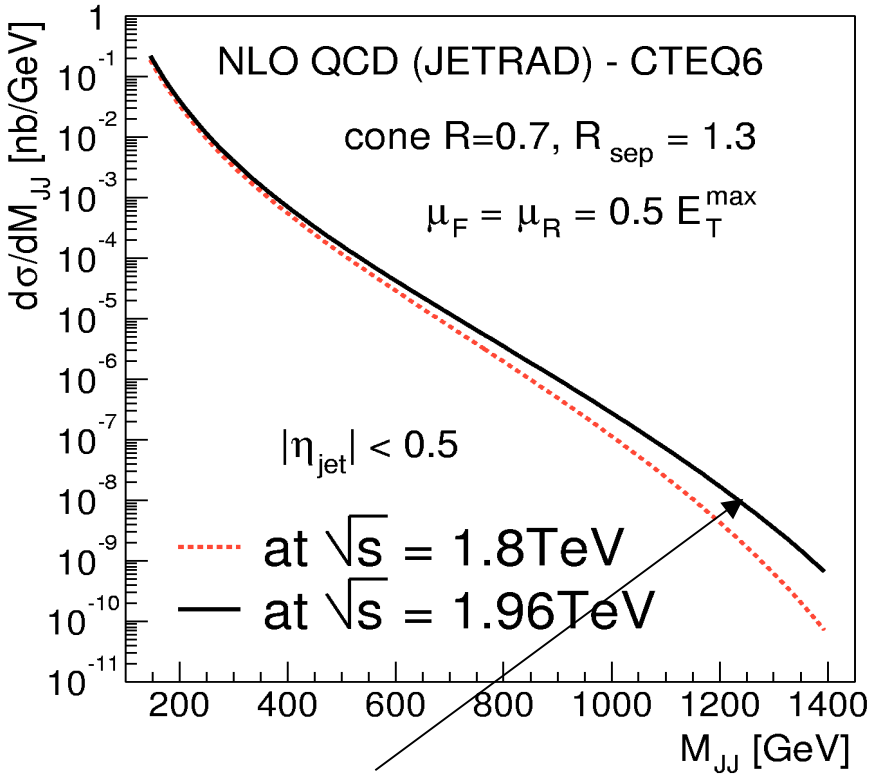
CDF since June 2001
Delivered ~ 300 pb^{-1}
Recorded ~ 230 pb^{-1}
Summer 2003 prelim. results ~ 140 pb^{-1}



DØ since April 2002
Delivered ~ 240 pb^{-1}
Recorded ~ 180 pb^{-1}
Summer 2003 prelim. results ~ 130 pb^{-1}

Dijet cross section from DØ

- probe of
  - QCD
  - proton structure at large x
  - hunting for resonances
  - quark compositeness
- data sample:
  - 34.1 pb^{-1}
  - $\not{E}_T/P_{Tj1} < 0.7$
  - primary vertex:
    - $|Z_{vtx}| < 50$ cm
    - $N_{trks} \geq 5$
- selection & sample definition:
  - cone jets ($R_{cone} = 0.7$)
  - $|\eta_{jet}| < 0.5$
  - $N_{jet} \geq 2$
  - jet quality cuts

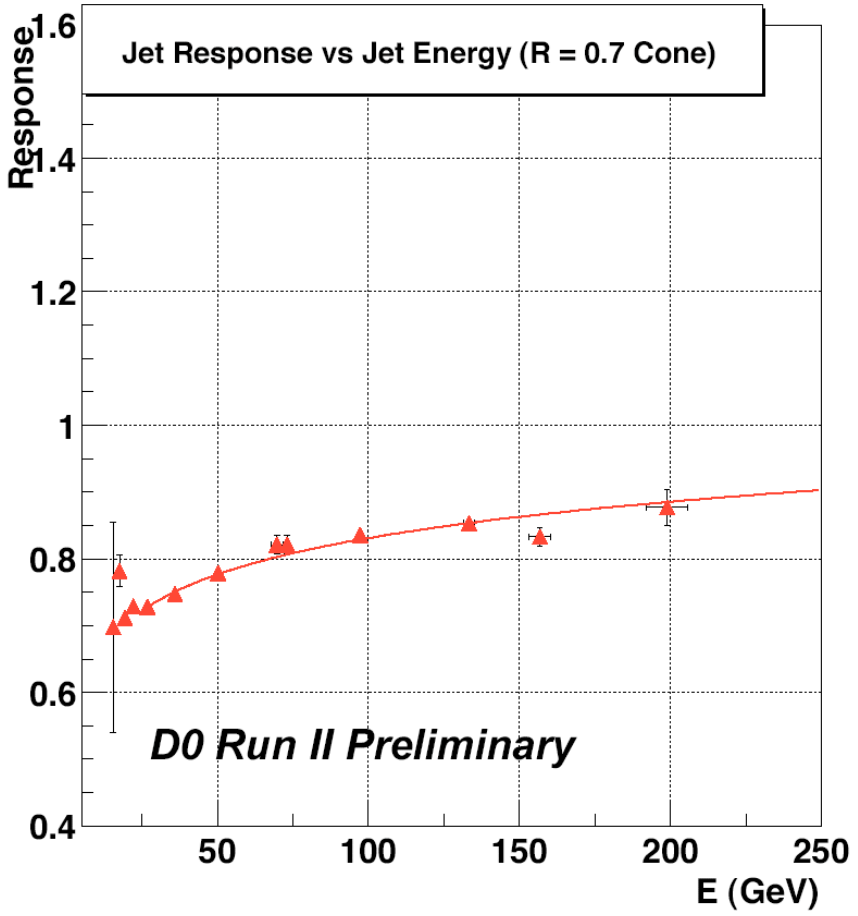


twice the σ at 1.96 TeV

Jet energy scale

$$E^{jet}_{particle} = \frac{E^{jet}_{det} - O}{R_{jet} S}$$

- **Offset (O):**
  - energy not asspciated with hard interaction (U noise, previous events, additional pp interaction)
- **Response (R_{jet}):**
  - calorimeter response to jet
  - EM part calibrated on $Z \rightarrow ee$ mass peak
  - measured from E_T balance in γ+jet events
- **Showering (S):**
  - losses due to showering out of jet cone

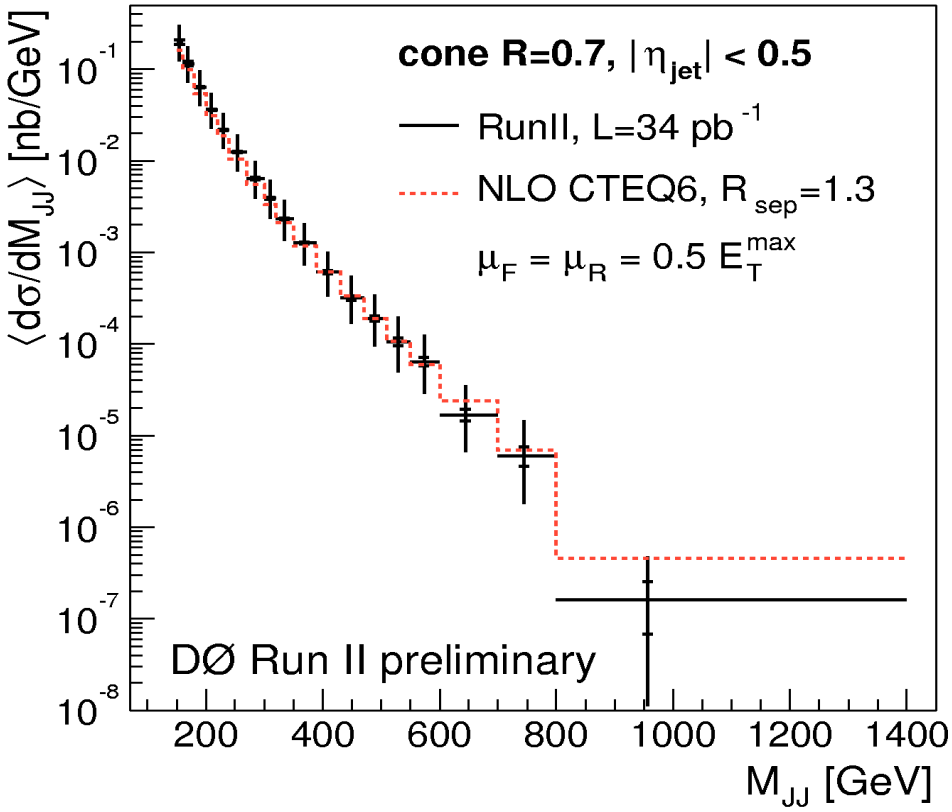


Observed cross section

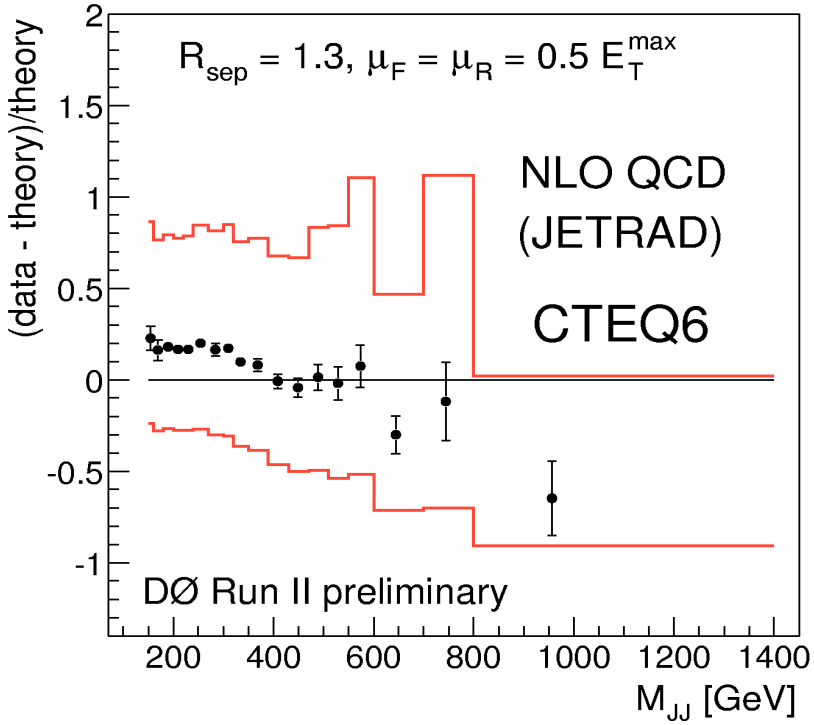
- calculated by

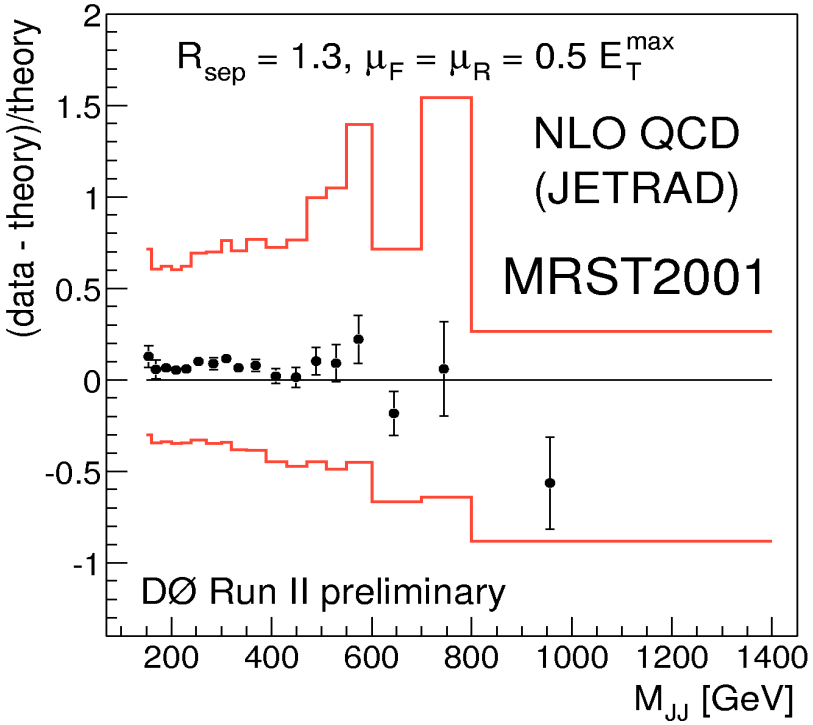
$$\left\langle \frac{d\sigma}{dM_{JJ}} \right\rangle = \frac{N_{event}}{L \cdot \Delta M_{JJ}} \times \frac{C_{unsmear}}{\varepsilon_{eff}}$$

  - cut efficiencies
    - estimated from data
    - jet quality: ~97%
- cross section
  - with total error
  - luminosity error
    - additional 10%
    - fully correlated bin-to-bin and not shown
  - compare to NLO theory
    - CTEQ6M pdf
    - R_{sep} = 1.3



Comparison to theory

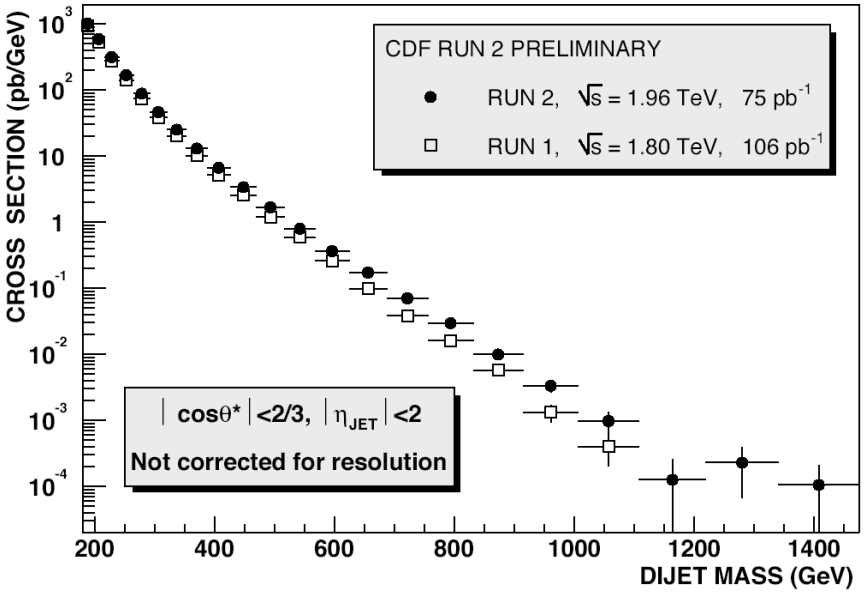


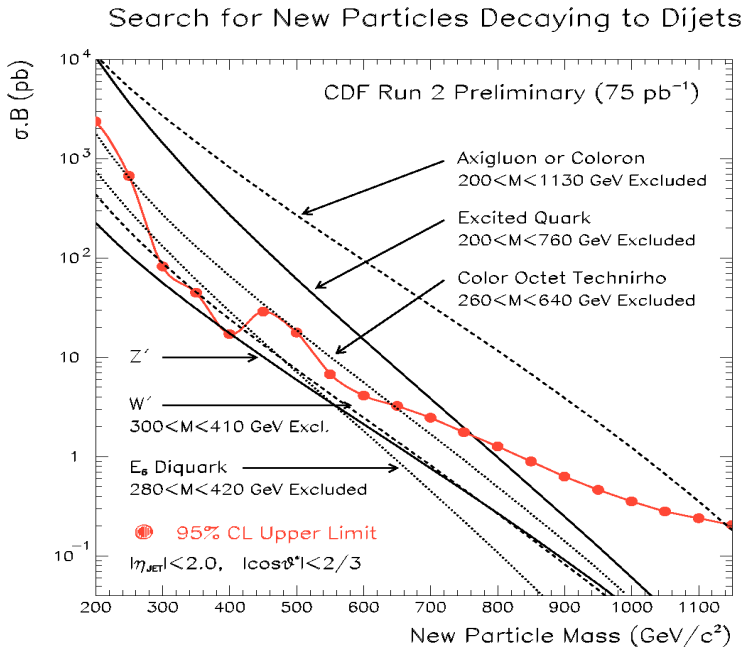


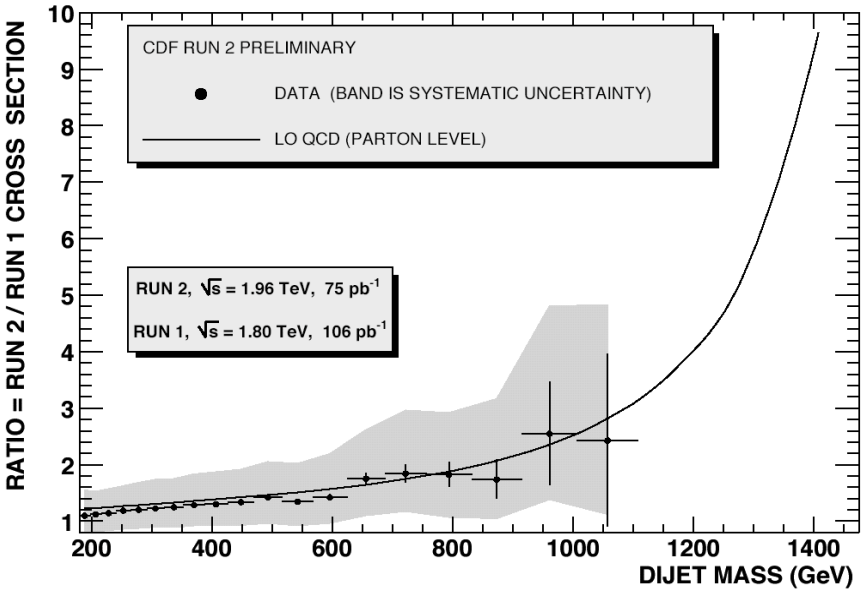
- **agrees within uncertainties**
- **error on luminosity not shown (10%)**
- **main uncert.: jet energy scale, P_T resolution, jet quality**
  - **dominated by jet energy scale error**
    - **150 to 160 GeV: +52% - 38%**
    - **800 to 1400 GeV: +190% - 73%**

Dijet cross section from CDF

- larger Run II data sample:
  - 106 pb^{-1}
- preliminary Run II limits for resonances in 2-jets mass for 75 pb^{-1} sample
- already reaching comparable or higher limits than in Run I



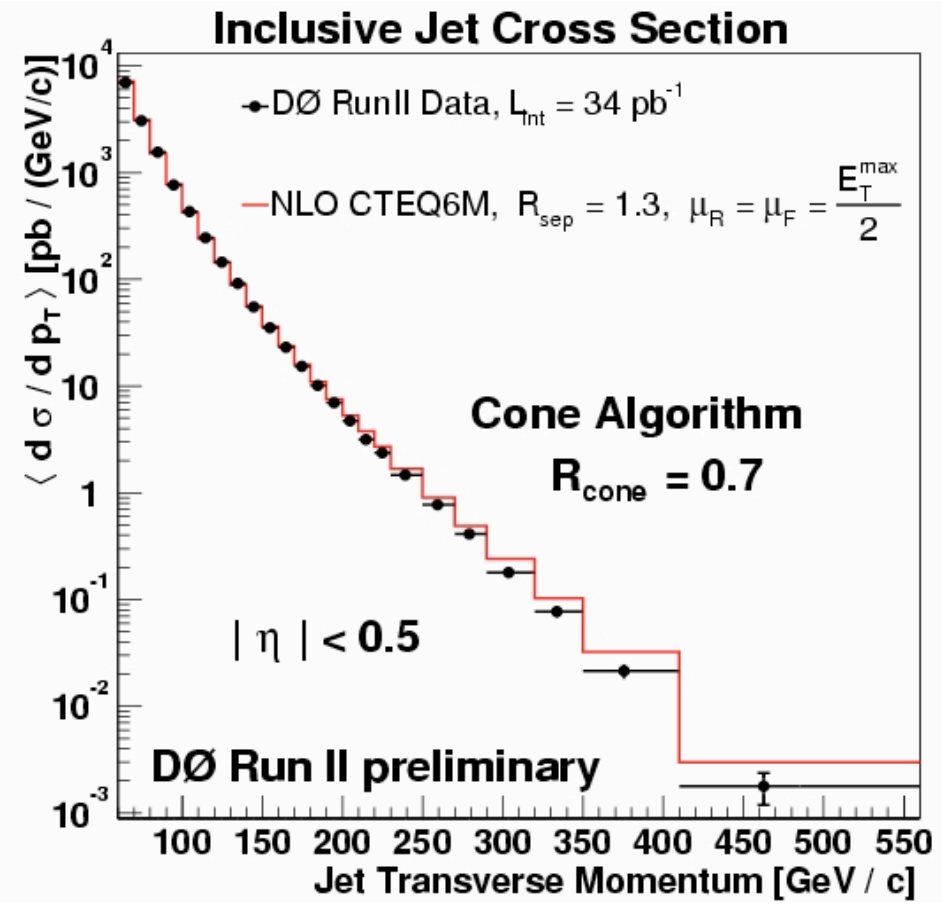




Inclusive jet cross section from DØ

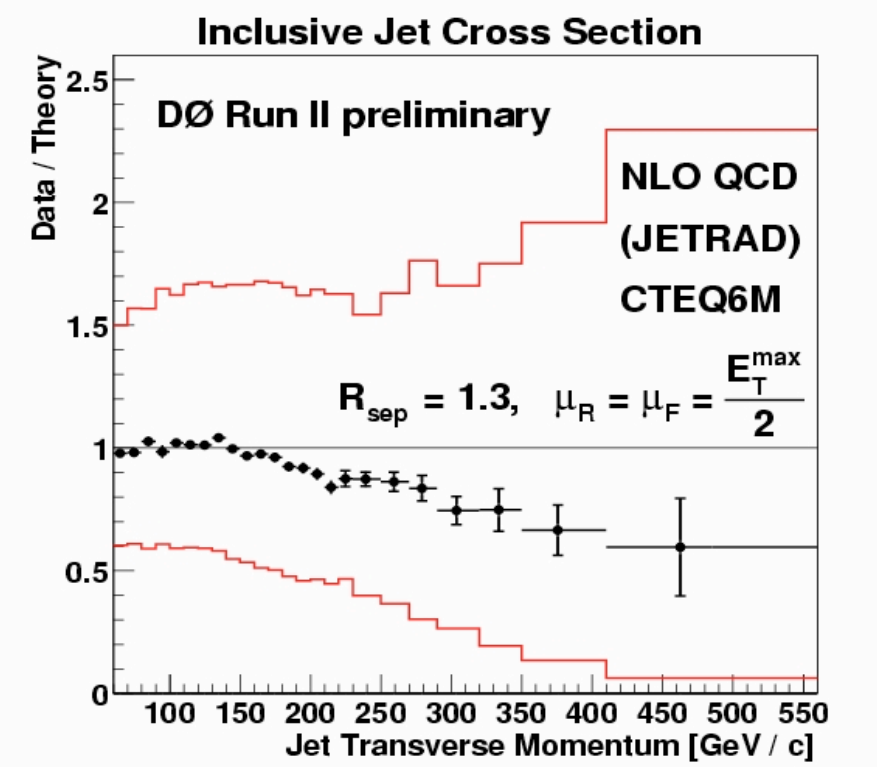
- **data sample:**
  - **34.1 pb^{-1}**
  - **$\not\!\!E_T/P_{Tj1} < 0.7$**
  - **primary vertex:**
    - $|Z_{vtx}| < 50$ cm
    - $N_{trks} > 4$
- **selection & sample definition:**
  - **cone jets ($R_{cone} = 0.7$)**
  - **$|\eta_{jet}| < 0.5$**
  - **$60 < P_{Tjet} < 560$ GeV**
- **calculated by**

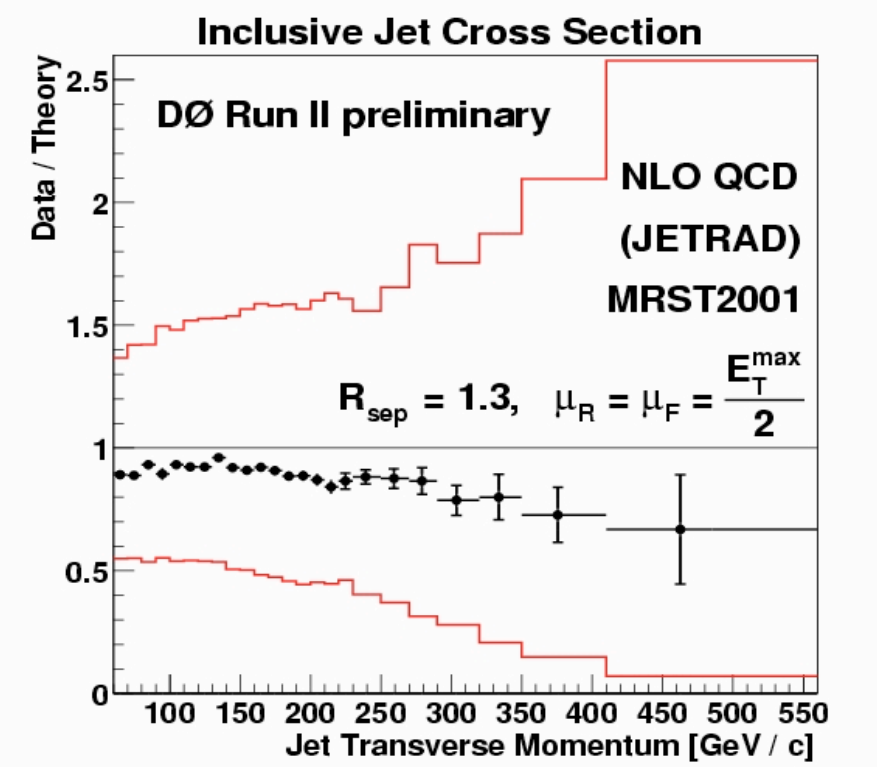
$$\left\langle \frac{d\sigma}{dp_t} \right\rangle = \frac{N_{event}}{L \cdot \Delta p_T} \times \frac{C_{unsmear}}{\varepsilon_{eff}}$$



- **ε_{eff} estimated from data**
- **theory: CTEQ6M pdf**
- **data points: only stat. errors**

Comparison to theory

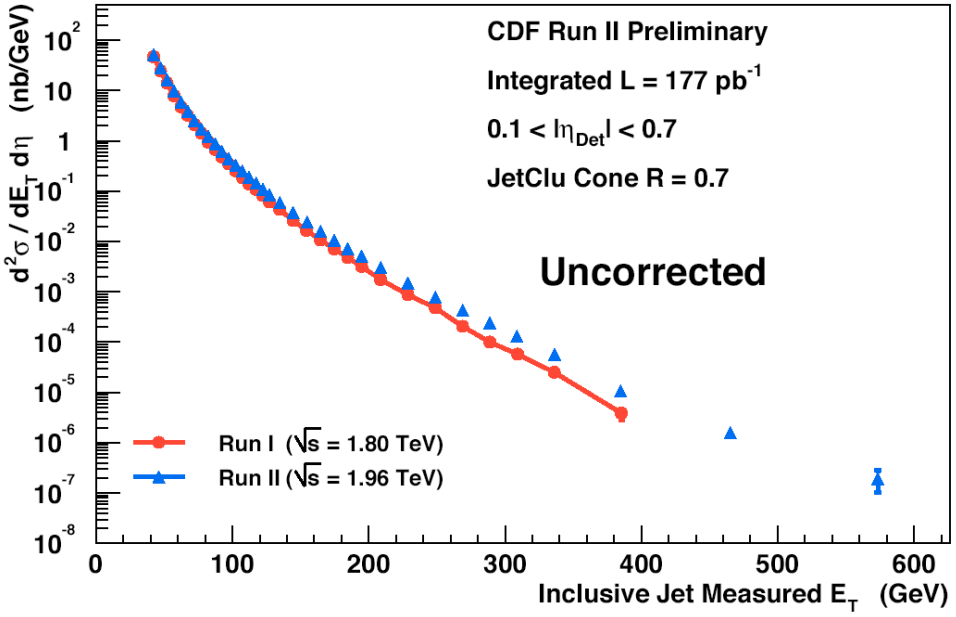


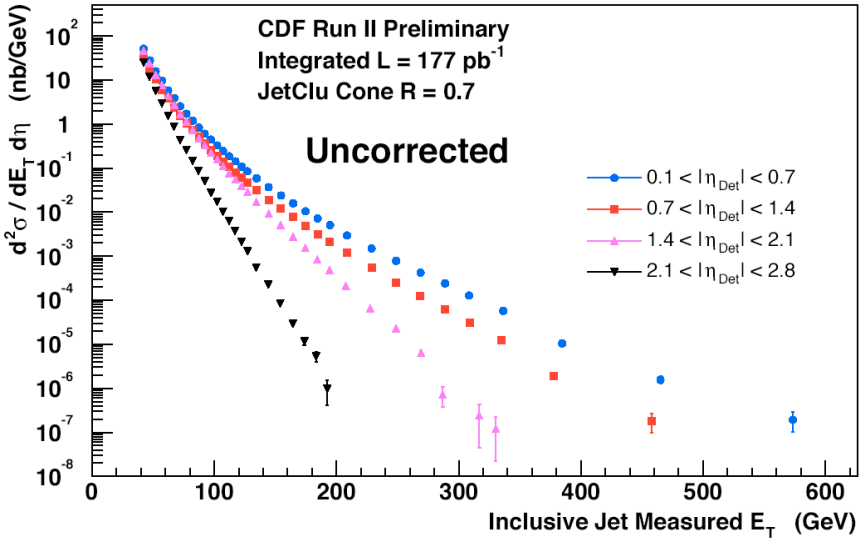


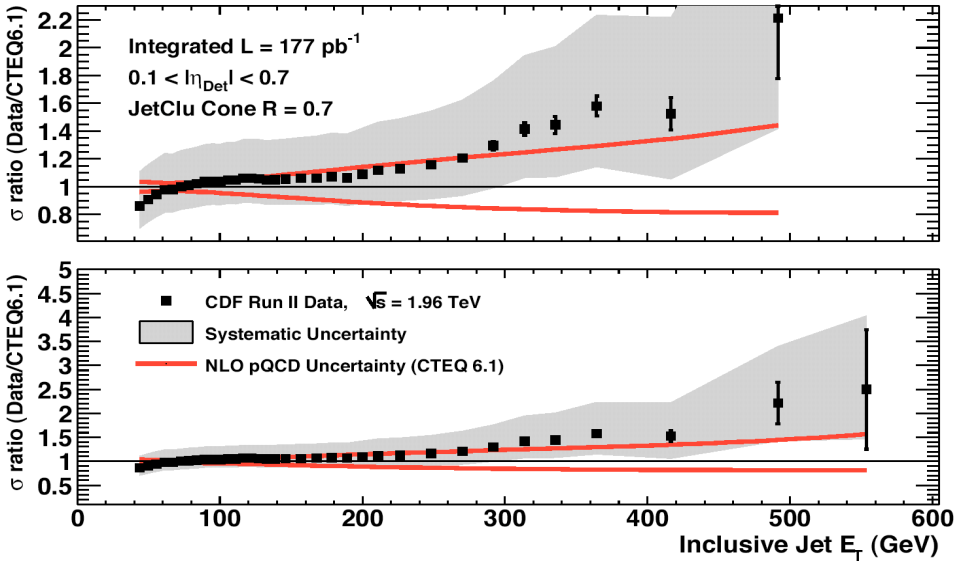
- agrees within uncertainties
- error on luminosity not shown (10%)
- main uncert.: jet energy scale, P_T resolution, jet quality
  - dominated by jet energy scale error
    - ~9% for central jets, $P_T < 200$ GeV
    - reduced statistics, extrapolation to higher P_T

Inclusive jet cross section from CDF

- larger data sample:
  - 177 pb^{-1}
- selection & sample definition:
  - cone jets ($R_{cone} = 0.7$)
  - $0.1 < |\eta_{jet}| < 0.7$
- overal energy scale normalized to Run I (with 5 ± 3% correction factor)
- reapply p_T-dependent systematics from Run I
- Preliminary cross section measurements for $|\eta_{jet}| < 2.8$

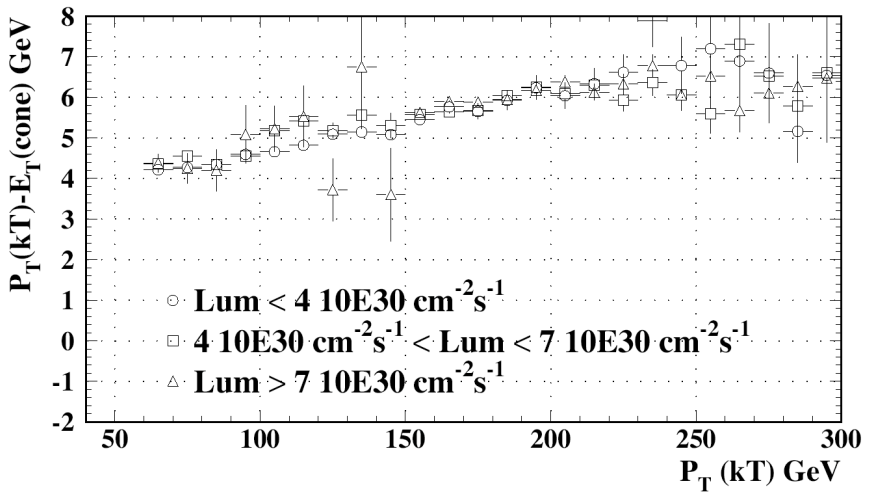


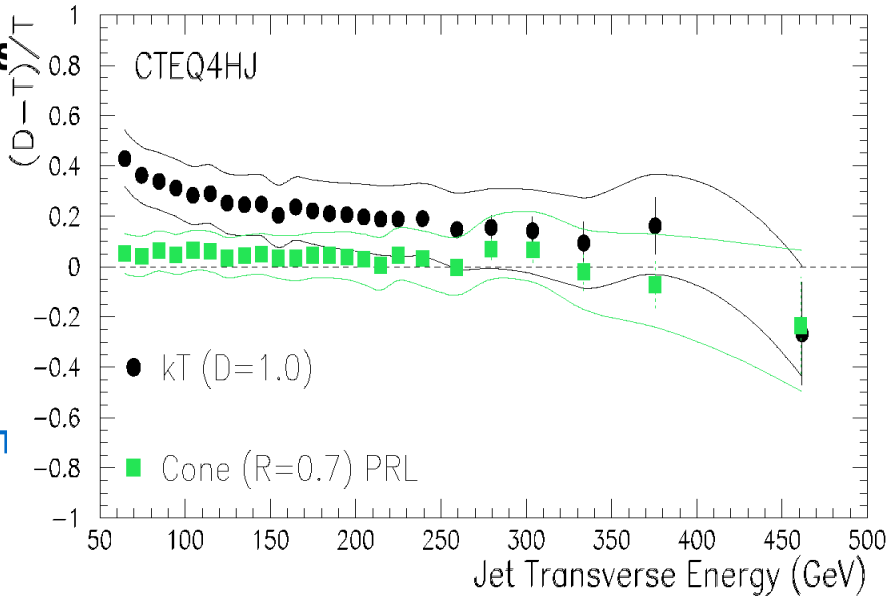




k_T and cone jets at DØ

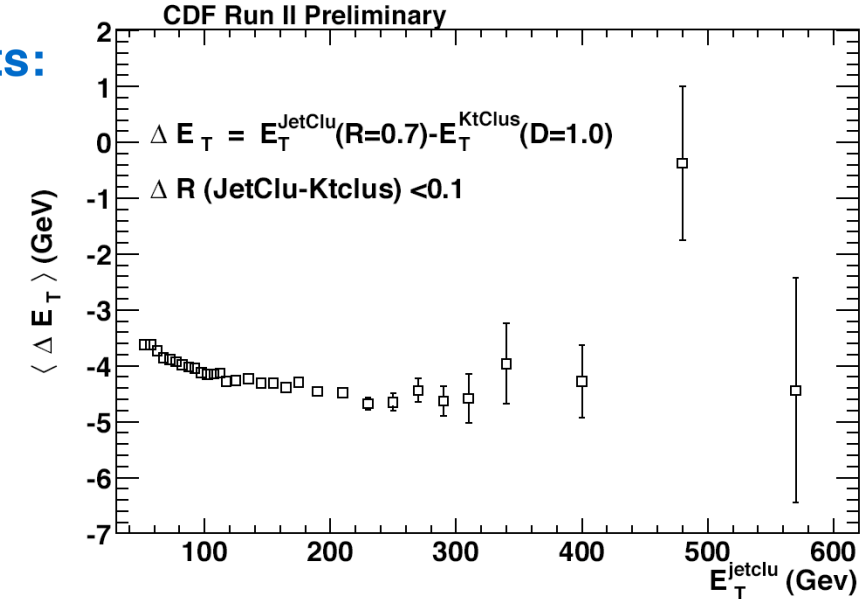
- compare E_T of cone and matched k_T jets:
  - chose cone jet
  - find correponding kT jet (matching req. $\Delta R < 0.1$)
- compare inclusive jet cross sections
- data sample:
  - 88 pb^{-1} (Run I data)
  - $\sqrt{s}$ = 1.8 TeV
- D = 1.0:
  - within 1% same NLO cross section as cone with $R_{cone} = 0.7$
    - up to 4-7 GeV higher p_T in k_T jets
- main uncertainties:
  - jet energy scale
  - luminosity
- reasonable agreement, marginal at low p_T
- data corrected to particle level buttheory is NLO at parton level

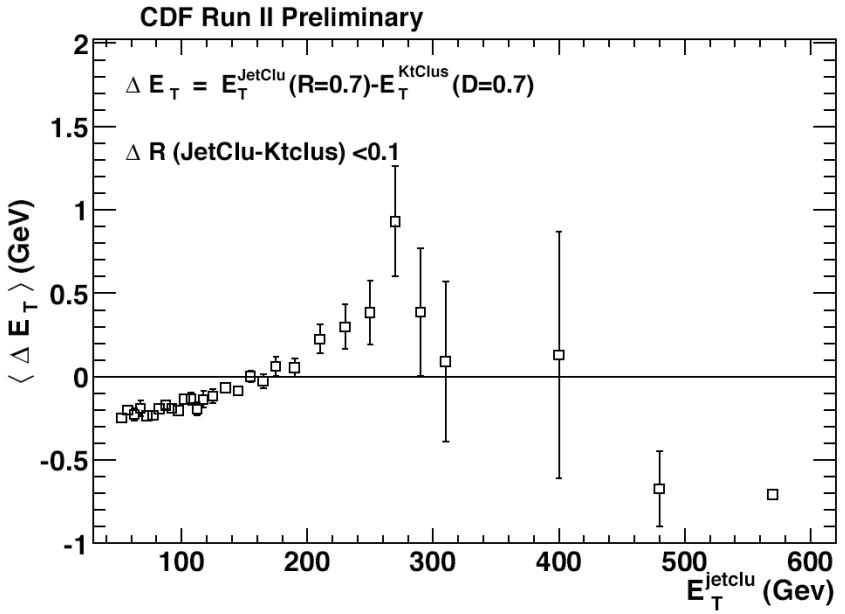




k_T and cone jets at CDF

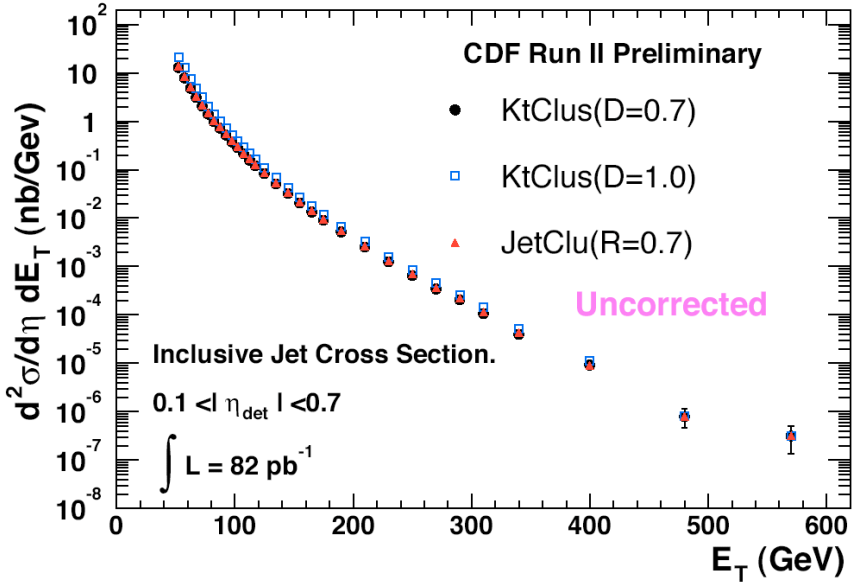
- compare E_T of cone and matched k_T jets:
  - ΔE_T(cone - kT) vs E_T(cone)
- data sample:
  - 82 pb^{-1}
  - $\Sigma E_T < 1.96$ TeV
  - primary vtx: $|Z_{vtx}| < 60$ cm
- D = 0.7:
  - small differences to cone jet ($R_{cone} = 0.7$).
- D = 1.0:
  - up to 4-5 GeV higher E_T in k_T jets

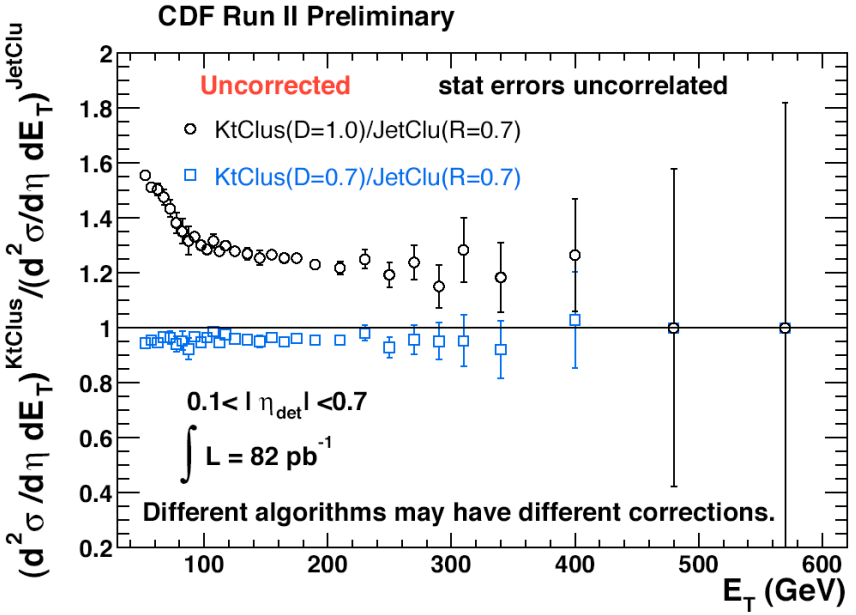




k_T and cone jets: inclusive jet cross sect.

- **Large difference between D = 0.7 and D = 1.0**
- **Different shape at low E_T**
- **Long term goal**
  - measure jet cross section using the Run II jet algorithms
  - derive jet energy correction
  - stufy jet fragmentation
  - study energy contributions from underlying event
  - …





Conclusion

- **preliminary results on the central inclusive jet p_T and dijet mass spectra:**
  - **Run II dataset larger than Run I**
  - **measured cross sections agree with predictions from NLO QCD over 7 orders of magnitude**
  - **dominant systematic uncertainty: calorimeter jet energy scale**

- **prospects for Run II:**
  - **extend the measurements to the forward region**
    $\rightarrow$ sensitivity to high x gluon
  - **higher statisicts, reduced systematics**
  - **α_s mesuruments**